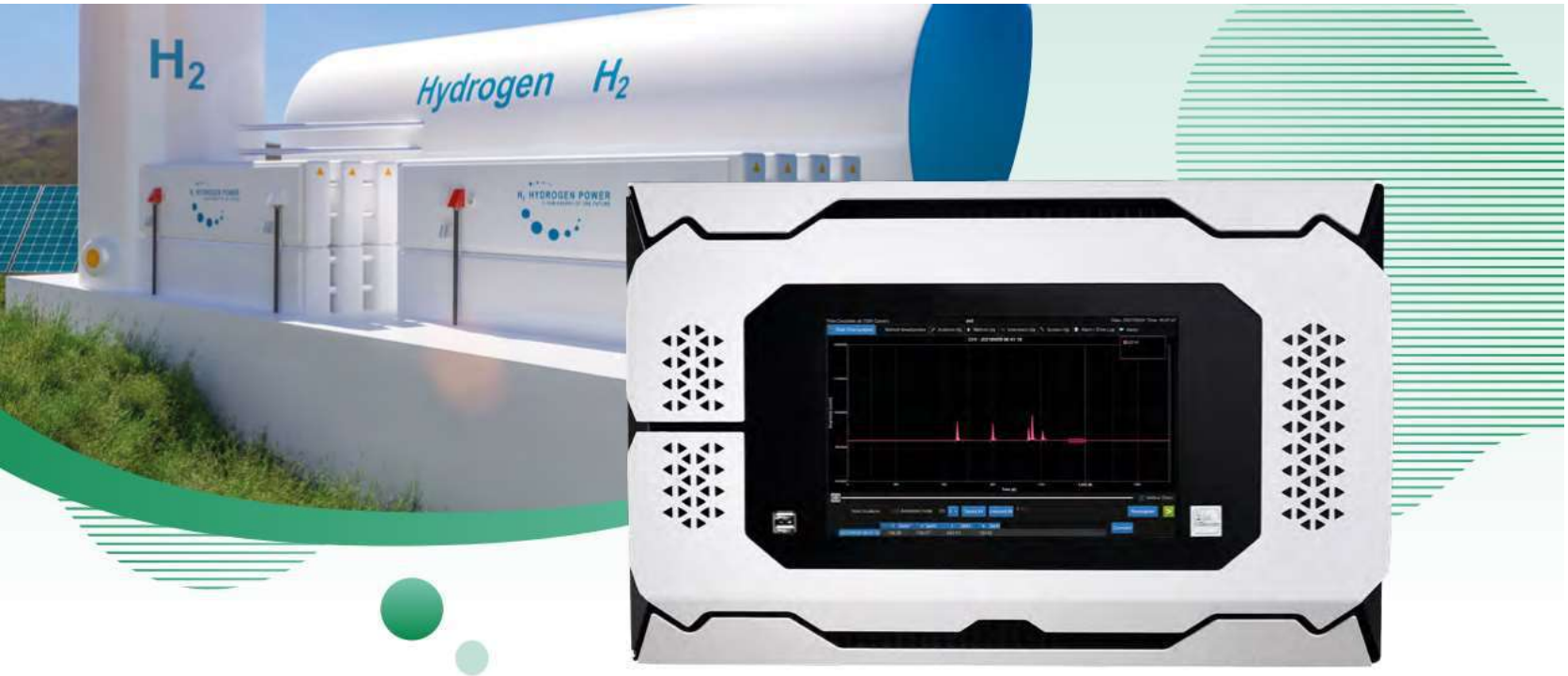

ASDevices

World's first fuel-cell hydrogen process analysis solution

Trusted by leading petrochemical company for real-time hydrogen purity measurement in eco-friendly vehicles at the Beijing 2022 Olympics.

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30 years of innovation in ultra-trace analysis

Our team has dedicated its career to the **improvement of ultra-trace analysis**. We have designed many new technologies resulting in over **180 patents** and many breakthroughs.

1992
K2000: The first digital trace N2 analyzer

1997
K2002: The first digital ultra-trace N2 analyzer

2000
K4000: The reference for trace N2 and Ar analysis for semiconductor

2007
Introducing the first purged GC valve

2017
ASDevices is born – Combining 30 years of knowledge

2018
R&D for hydgen purity analysis

2021
ASDevices release first process analytical solution for H_2 purity analysis

We are proud to say that our team has developed technologies that are used **today on most Air Separation Plants and Semiconductor Fabs.**

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Yves Gamache

Chairman & Chief Innovation Officer

Yves Gamache has a long-standing passion for instrumentation, automation and analytical process control. In a career devoted to technological development and enhancement, he has become a world-renowned expert and pioneer in gas chromatography, with 166 distinct patents dealing with over 30 different topics. His key accomplishments include developing the first plasma emission detector (PED) to become a worldwide industry standard in the field of air separation, used for measuring argon purity. This technology is currently being applied to protect magnets in the large hadron collider in Switzerland.

André Lamontagne, Ing., EMBA

President

As a seasoned business leader, André Lamontagne is known for his ability to implement innovative strategies by combining his analytical skills and business acumen. With 20 years of experience in analytics and world-renowned expertise in gas chromatography, he is the author of four patents in the field of gas analysis, and four more in the healthcare sector. In 2014, he was one of only 100 people admitted to the Harvard Business School EMBA, out of 800 applicants. He co-founded Spira Innovation after heading the R&D operations at Contrôle Analytique and Servomex.

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Product tree

Analytical components

GC platforms & software

- iMOv
- miniMOv
- GCSense
- miniGCSense
- Chromatographic processing module (CPM)
- ASDSense software

Detectors

- SePdd
- Mini SePdd
- eFID
- TCD

Purifiers

- Intelligent plasma assisted purification system (PAPS)
- Pure

Supporting accessories

- Autosampler
- Sample stream selection system (S4)
- Manual sample stream system (MS2)
- Gas calibration system (GCS)
- Sample concentration system (SCS)

Products under development

- Helium recycling
- Field enhanced photo ionization detector (FePID)
- eDID
- Capillary detector
- Metastable emission and ionization detector (MEID)

Mechanical components

Valves, tubes, fittings, column

- Purged lip sealing valve (PLSV)
  - Switching
  - Sample selection
  - Trap and release
- Purged pulse diaphragm valve (PPDV)
- HPLC wear proof valve
- Analytical tubes
- Compression fittings
- Analytical fittings
- ArDSieve column

Turnkey solutions

GC solutions

- KA5000plus
- KA6000plus
- KA8000plus
- KA8000Ex

Continuous gas analysis solutions

- Sense series
- Trace nitrogen in argon/helium
- Trace hydrocarbon
- Trace O_2
- Trace CO_2

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We proudly own all of our key gas chromatography technologies

ASDevices intellectual properties

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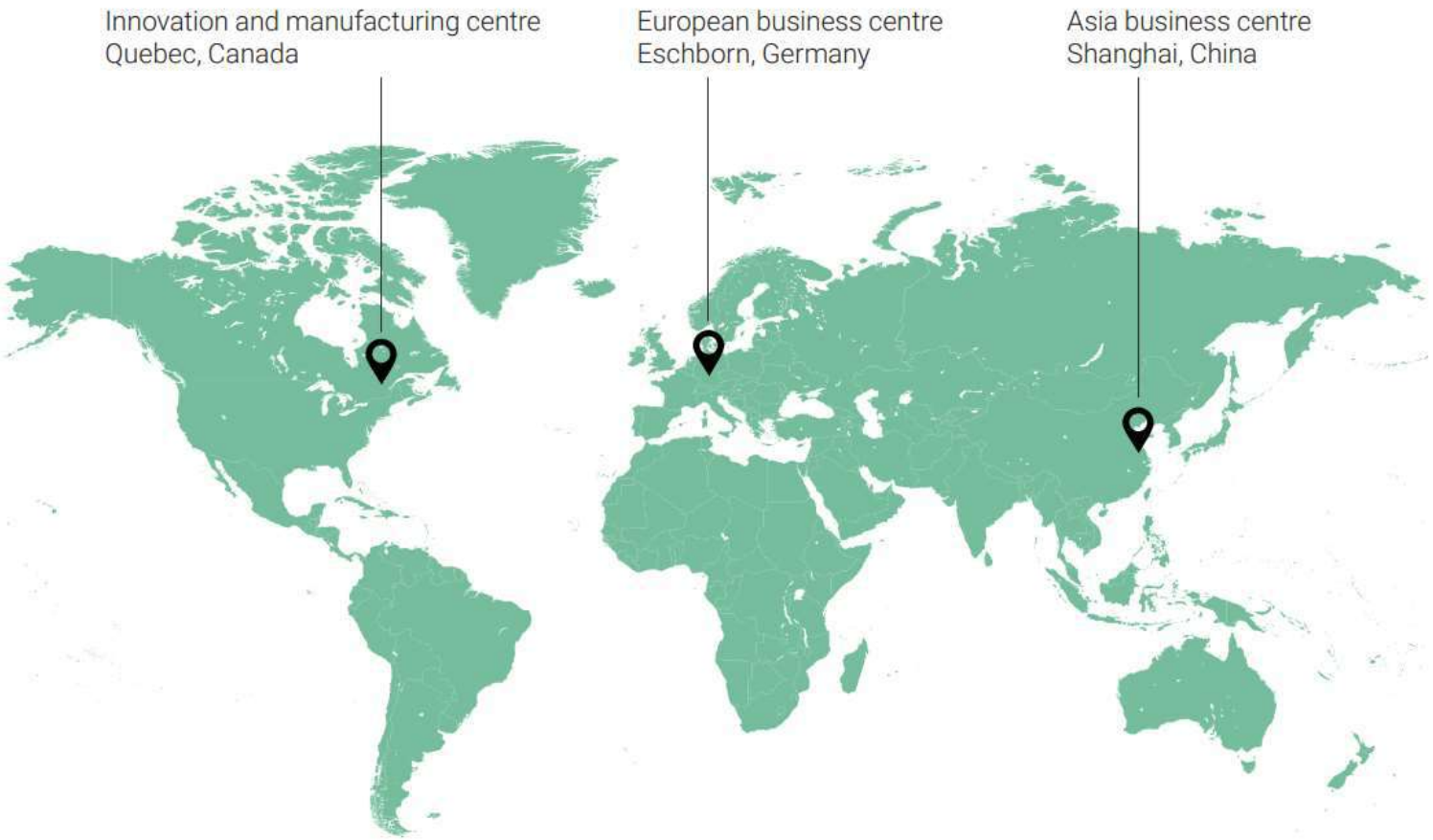
A global reach to better support our customers



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ISO FDIS 14687-2 STANDARD FOR FUEL-GRADE H_2

- Many key contaminants can reduce the efficiency of fuel cells
- CO and sulfur-based compounds can cause irreversible damage to the fuel cell components
- Sulfur-based compounds include H_2S, COS, CS_2, mercaptans (R-SH/R-S-R) and disulfides (R-S-S-R)
- Total sulfur is currently limited to 4ppb. Due to its important effect on the durability of fuel cells, future standards may require even lower concentrations [1]
- Highly sensitive and reliable instruments are required for accurate sulfur analysis in fuel-grade hydrogen.

Water (H_2O)	5 ppm
Total hydrocarbons	2 ppm
Oxygen (O_2)	5 ppm
Helium (He)	300 ppm
Total Nitrogen (N_2) and Argon (Ar)	100 ppm
Carbon Dioxide (CO_2)	2 ppm
Carbon Monoxide (CO)	0.2 ppm
Total Sulfur Compounds	0.004 ppm
Formaldehyde (HCHO)	0.01 ppm
Formic Acid (HCOOH)	0.2 ppm
Ammonia (NH3)	0.1 ppm
Total Halogenated compounds	0.05 ppm
Total Non-Hydrogen Gases	300 ppm

[1] U.S. Department of Energy, Hydrogen Fuel Quality Specifications for Fuel Cells in Road Vehicles, 2016.

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CHALLENGES WITH PROCESS-ORIENTED METHOD FOR SULFUR ANALYSIS IN HYDROGEN

- **Process-oriented method**: Must be automated, highly sensitive, stable and accurate, easy and safe to use, low and easy maintenance

- Highly reactive compounds = Measurement instability and inaccuracies. Require high-quality passivated (ex. sulfinert-treated) components (tubing, valves, detector, etc.).

- Sample pre-concentration often required: Multiple additional parts required. Much more complex and expensive systems

- Hydrogen is a small molecule. Require excellent GC valves due to cross-port leaks.

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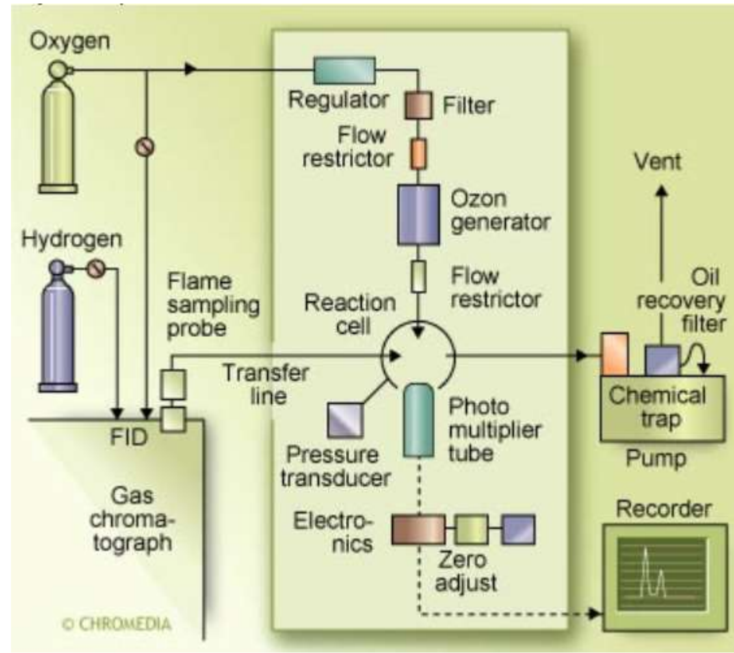
HYDROGEN ANALYSIS WITH SCD

- In 2011, the NPL (United Kingdom) developed a method for sub-ppb analysis of sulfur-based compounds in fuel-grade hydrogen by gas chromatography (GC) coupled with Sulfur Chemiluminescence Detector (SCD) [2]

- Advantage:

  Highly sensitive

  Specific to sulfur-based compounds



$RS + O_2 \rightarrow SO^* +$ other reaction products

$SO^* + O_3 \rightarrow SO_2^* + O_2$

$SO_2^* \rightarrow SO_2 + h\nu$

[2] A. S. Brown, *et al*. Methods for the Analysis of Trace-Level Contaminants in Hydrogen for Fuel Cells Applications, NPL Report AS 64, 2011.
[3] http://www.chromedia.nl/chromedia?waxtrapp=yzdhcDsHqnOxmOlIEcCbCqEjEuBX&subNav=oubgcDsHqnOxmOlIEcCbCqEjEuBX

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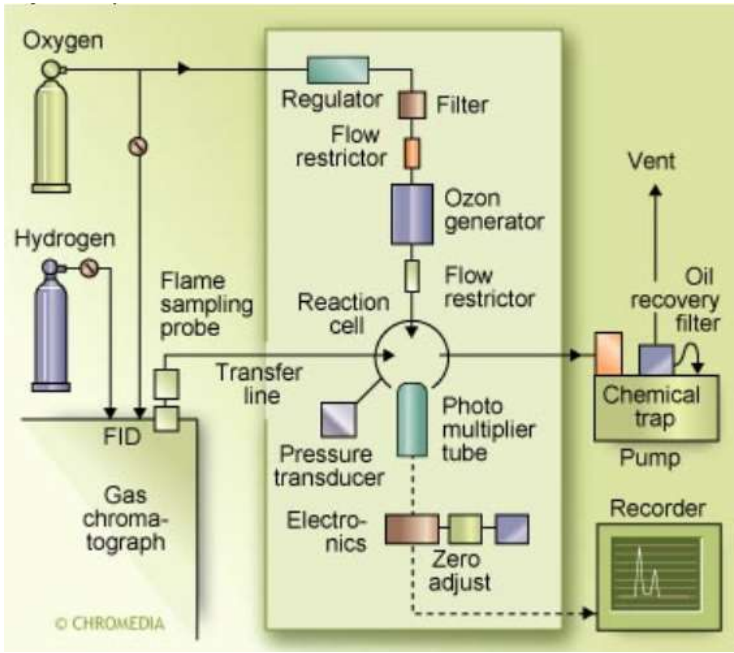
HYDROGEN ANALYSIS WITH SCD

- **Disadvantages:**
  - -Bulky and complex detector
  - -Require highly toxic ozone (and ozone traps)
  - -Highly sensitive to moisture (require multiple moisture traps)
  - -Response depends on the position and condition a ceramic probe
  - -Require frequent maintenance (ceramic probe and other components)
  - -Expensive system: more than 40 000$ for de detector only
  - -Must be operated by skilled professionnals
  - -**Not** adapted for process monitoring



$$RS + O_2 \rightarrow SO^* + \text{other reaction products}$$

$$SO^* + O_3 \rightarrow SO_2^* + O_2$$

$$SO_2^* \rightarrow SO_2 + h\nu$$

[2] A. S. Brown, *et al*. Methods for the Analysis of Trace-Level Contaminants in Hydrogen for Fuel Cells Applications, NPL Report AS 64, 2011.

[3] http://www.chromedia.org/chromedia?waxtrapp=yzdhcDsHqnOxmOIlEcCbCqEjEuBX

HYDROGEN ANALYSIS WITH FPD

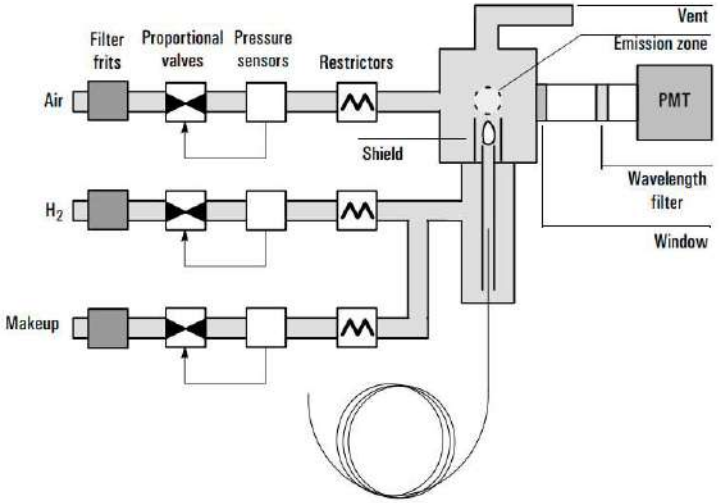
- The Flame Photometric Detector (FPD) is more simple to operate than the SCD. Similar to Flame Ionization Detector (FID), but measure light emission (394nm) from S_2 radicals generated in the H_2 flame

- It is less sensitive than SCD (50ppb for most compounds)

  *ISO standard require 4ppb

- Pulsed FPD (PFPD) is more sensitive, but also more complicated to operate. It requires two different combustible gas flow and a gated amplifier to record specific components of each pulse.

- PFPD is **not** adapted for process monitoring



[4] http://www.ecs.umass.edu/eve/facilities/equipment/Agilent6890/The%20Flame%20Photometric%20Detector.pdf

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Sinopec Yanshan plant
Fuel grade H_2 quality analysis for 2022 Winter Olympics

Designed for process
We have many systems installed all over the world.

Our technologies
Advancing gas chromatography and gas analysis for 3 decades

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info@asdevices.com

Designed for labs
We have systems installed all over the world.

The performance and quality of our solution is not down to one technology, it is down to a combination of technologies we developed and knowhow. **We have 30 years of experience.**

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Analytical **system measurement** capabilities

			Achievable limits of detection	
Analytes	Sensing technology	Method	Standard version	High sensitivity version*
O_2	SePdd	Continuous	100 ppb	10 ppb
N_2	SePdd	Chromatography	100 ppb	10 ppb
Ar	SePdd	Chromatography	100 ppb	10 ppb
CH_2	SePdd	Chromatography	100 ppb	10 ppb
CO	SePdd	Chromatography	100 ppb	10 ppb
CO_2	SePdd	Chromatography	100 ppb	10 ppb
He	TCD	Chromatography	100 ppm	10 ppm
Sulfurs	SePdd	Chromatography	< 0.5 ppb	< 0.1 ppb
THC	eFID	Chromatography	50 ppb	10 ppb
NMHC**	SePdd	Chromatography	10 ppb	10 ppb
H_2O	SePdd	Chromatography	100 ppb	100 ppb
	Al_2O_3	Continuous	100 ppb	100 ppb
Organic halogens (CH_3Cl, CH_2, Cl_2)	SePdd	Chromatography	< 5 ppb	< 5 ppb

* High sensitivity version available with Sample concentration system (SCS) for sulfur concentration

** Two options available for hydrocarbons analysis: SePdd detector with proprietary enhanced plasma discharge (Epd) technology for CH_4/NMHC or eFID detector for single THC peak.

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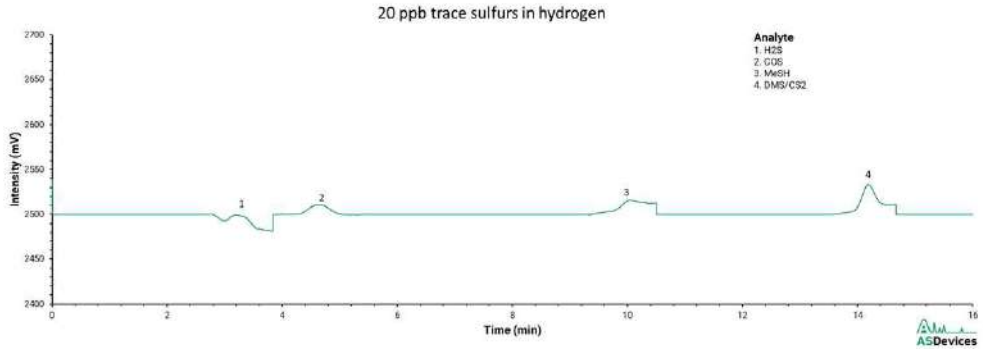

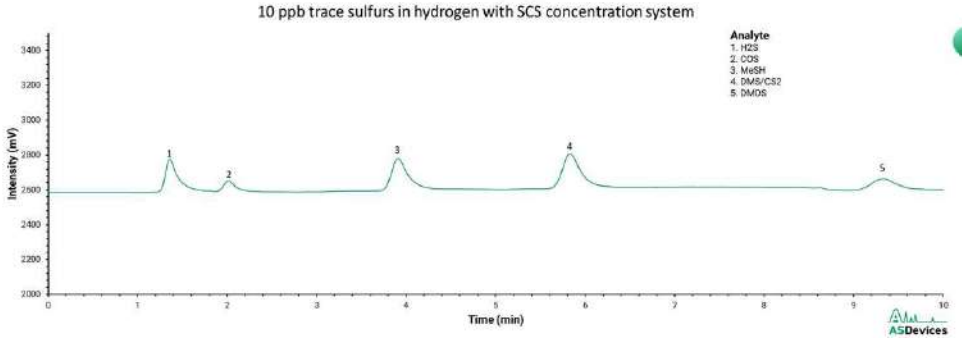

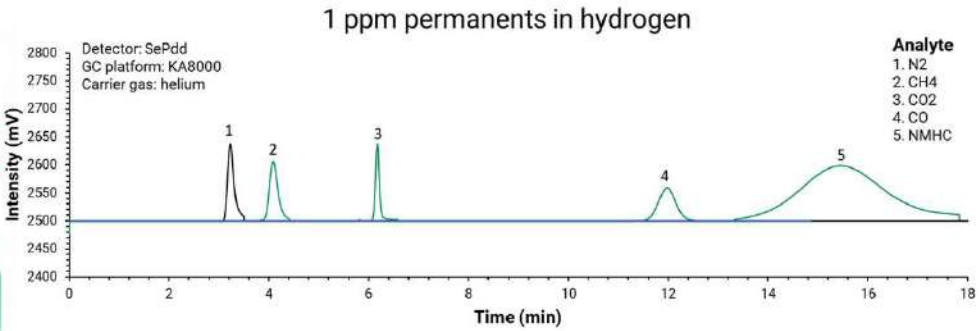

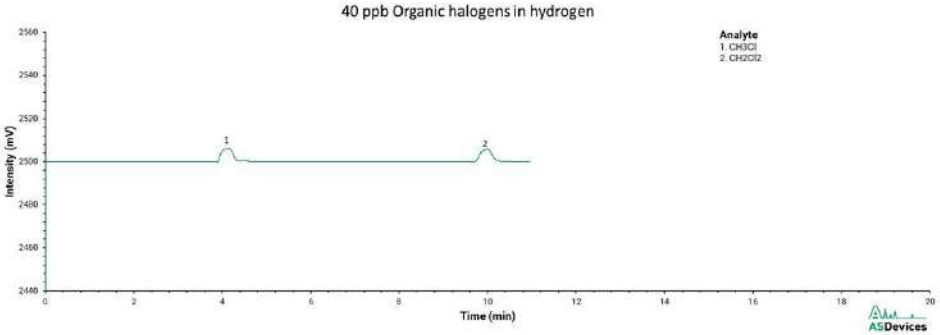

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DETECTORS

Where innovation meets **performance**

We offer multiple standard detectors and technologies that are unique to us, with sensors that have been developed to be robust and high performance. Although they're optimized for ASDevices GC platforms, they work just as well on any GC platform.

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SePdd

Scalable enhanced plasma discharge detector

Patented

Features

- Up to 2 detectors for the price of 1 (twin version)
- Up to 4 configurable optical wavelength modules (OWM)
- Patented Epd technology with stabilization and electron injection electrodes
- Highly robust with metal body discharge cell (patent pending)
- Optimized for packed, µpacked and capillary columns
- Can be integrated into any existing GC platform
- ppt to % measurement range
- High temperature and pressure operation with adjustable discharge gap
- Powered by our Chromatographic Processing Module (CPM)
- Compatible with argon, helium and nitrogen carrier gases (as well as others)

Typical applications

- **Permanent gas**
- **Sulfurs**
- **Mercaptans**
- Hydrocarbons
- VOC
- **Moisture**
- Aldehydes
- Chlorocarbons

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EPD
Enhanced Plasma Discharge

Patented

Epd plasma cell

1 Quartz to metal thermal joint

Allow thermal expansion while maintaining leak integrity
Prevent electrode breakage

2 Heather mounting hole

Metal body allows uniform heat transfer

3 Column inlet

4 Doping inlet or vent

5 Temperature sensor mounting hole

6 Optical port 1 and 2

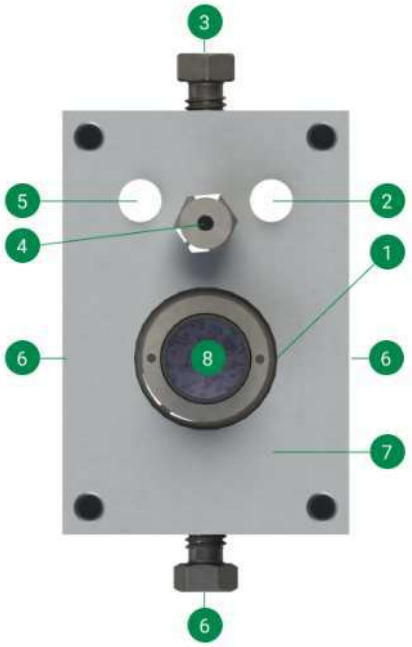
- UV treated sapphire
- Other materials available

7 Discharge cell body

- Metal body with proprietary coating
- Available in ceramic
- Withstands high pressure

8 Compound electrode

- Discharge electrode
- Stabilisation electrode
- Electron injection electrode
- Premium quartz shell with proprietary treatment



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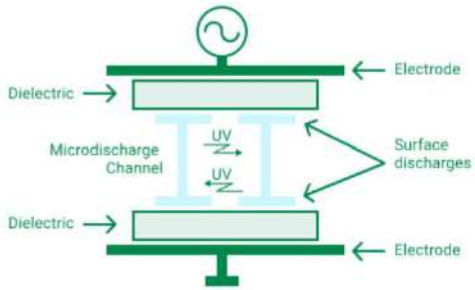
ASDevices

Patented

Stabilized dielectric barrier discharge (DBD)

PATENTED

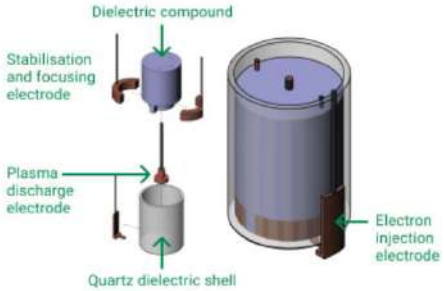
At the core of our Epd technology, a highly energetic plasma source is used to ionize molecules. Its unsurpassed performance is a result of the Epd stabilized dielectric barrier discharge. The DBD isolates the discharge electrodes from the ionized plasma, eliminating sputtering, cell inner wall coating and analyte interference.



Compound electrode

PATENT PENDING

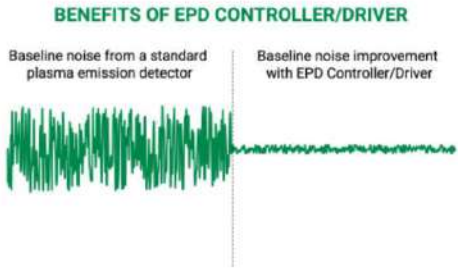
This major breakthrough comes from our innovative compound electrode (patent pending). By nature, DBD generates streamer discharges. This results in a noisy signal impacting the signal-to-noise ratio. The main advantage of our technology is that unlike other DBDs or plasma emission detectors (PEDs), our stabilization and electron injection electrodes (patent pending) are embedded in the compound electrode. This enables the electrode to improve stability by sweeping away the accumulation of charges on the inner surface wall.



Epd controller/driver

Even on its own, our compound electrode is unique. The level of performance achieved by the Epd, however, could not be attained without close control over various parameters that affect discharge power distribution. This is the purpose of the Epd controller/driver.

- Force-driven plasma discharge signal improves plasma
- stability compared to other plasma sensing technology
- Adaptive control of driving voltage and frequency
- Stabilization field automatically



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ASDevices

GC AND HPLC VALVES

Designed for **performance**

For over 20 years, we've been pushing the limits of the industry by designing the highest performing, most durable, finest quality valves. Today, we offer a complete range of GC and HPLC valves, no matter the application.

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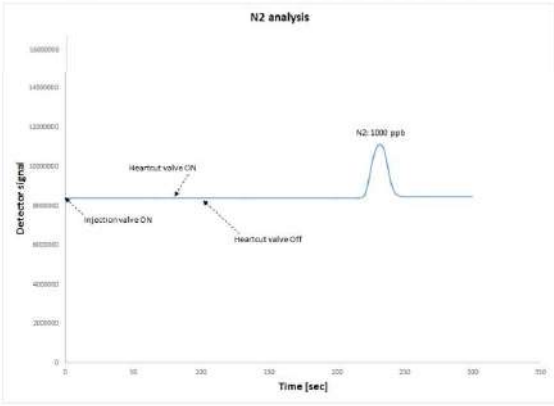
Purged lip sealing valve (PLSV)

Designed for performance

For over 20 years, we've been pushing the limits of the industry by designing the highest performing, most durable, finest quality valves. Today, we offer a complete range of GC and HPLC valves, no matter the application.

- **No leaks:** Unique purge technology eliminates inboard/outboard and cross-port leaks
- **Long lifetime:** Over 1 million actuations in UHP applications due to unique reduced surface area insert technology
- **Constant pressure drop:** No change in pressure/flow drop across temperature range and life span
- **No dead volume:** Internal flow path contains no unswept volume
- **Small footprint:** With our electrical or pneumatic compact actuator, multiple valves can be installed in a constrained space, replacing existing diaphragm valve

TEST RESULTS AFTER 1,000,000 ACTUATIONS



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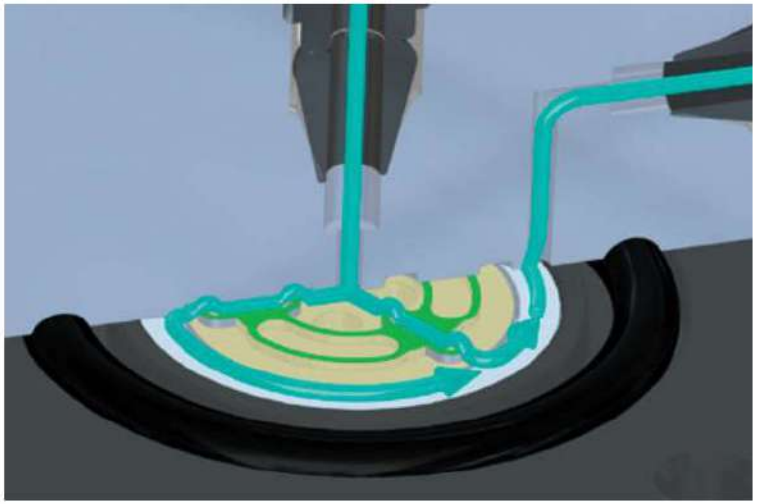
Patent pending

Leaks are virtually impossible by design

With its purging channels located between two adjacent valve channels and valve head purging pockets machined into the valve head, our PLSV's unique, patent-pending design does away with leaks. The pockets connect the purging inlet and outlet through the channels, allowing purge gas to flow freely. Since the volume around the insert and in between ports is continuously removed, there are no more inboard/outboard and cross-port leaks.



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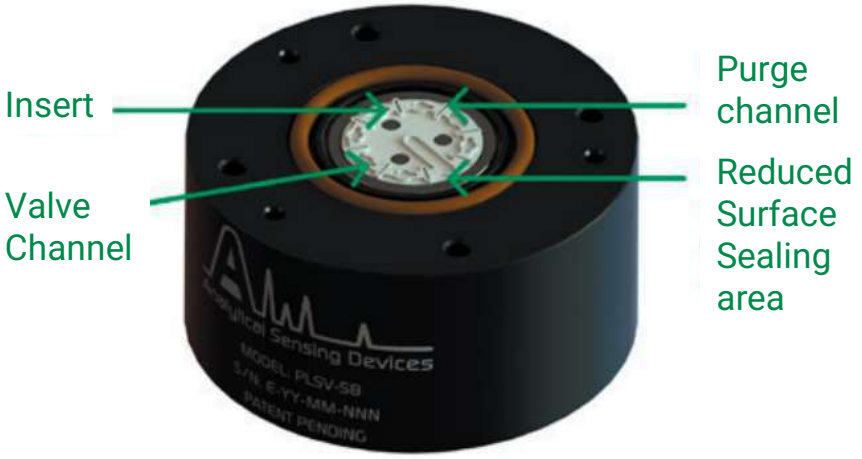
Patent pending

Improves lifetime with reduced surface sealing area

Using finite element modeling (FEM) and real-life testing, we optimized the sealing leap size and shape. The result is a sealing surface area that's 14% the size of a standard conical rotary valve, decreasing wear and tear and friction on the valve. What's more, the insert material is specially treated by a proprietary process that improves the surface finish, hardness and creeping.

Due to its reduced sealing force, the inert Coating on valve head does not peel like on Other valve technologies.

This valve technology greatly improve performance and lifetime. This Is unit to ASDevices.



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SUPPORTING ACCESSORIES

Designed to offer the best **analytical performance**

Whether it's for laboratory or process use, you can rely on our range of high-quality accessories designed to work with our own GC platforms – or any other GC platform you may be using.

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Sample concentration system (SCS)

Patent pending

Unsurpassed sample integrity

Available as both a 19-inch rackmount for iMOv or a stand-alone benchtop unit for miniMOv, our sample concentration system (SCS) is designed around our purge lip sealing valve (PLSV) trap and release (T&R) valve, for a unique configurable 4-step process that ensures sample integrity. When combined with our electrically cooled cold trap and flash heater, you'll benefit from only the best performance.

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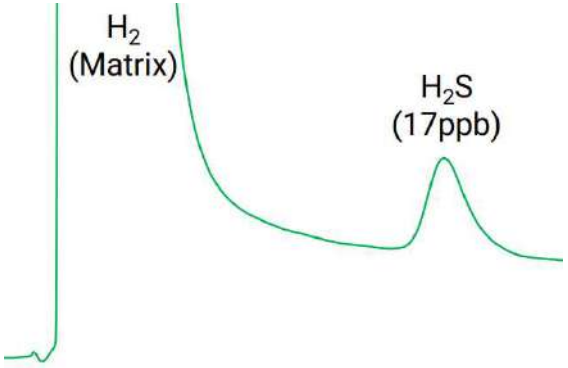
Used in high sensitivity version for sulfurs

Models

miniMOV iMOV



Features

- Unique configurable 4-step process: sampling, venting sample matrix, trap isolation and trap release
- Unsurpassed leak integrity with purge leap sealing valve (PLSV) technology
- Trapping temperature down to −30° C and release temperature up to 300° C
- Ballistic release temperature
- Split sample injection
- Inert flow path available

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Solution highlights

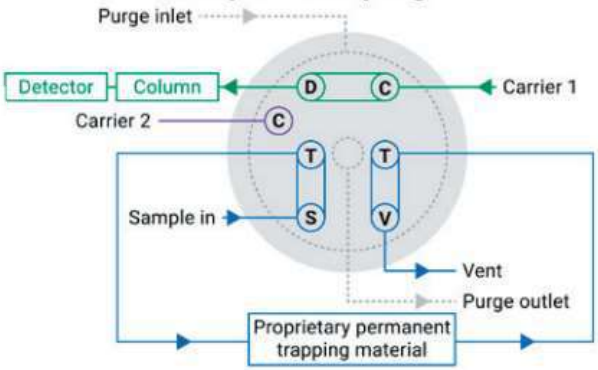
Unique configurable 4-step process

- Unique trap isolation step improves chromatography and peak sharpness
- Unique sample matrix vent step simplifies and improves chromatography
- No detector baseline shift during release stage due to PLSV technology's unsurpassed leak integrity

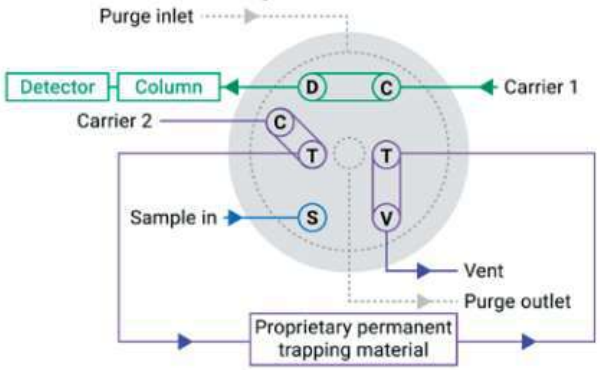
Powered by PLSV valve technology

Patent pending

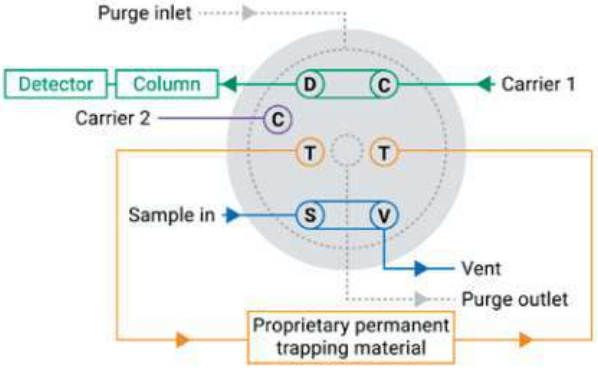
Step 1 – Sampling



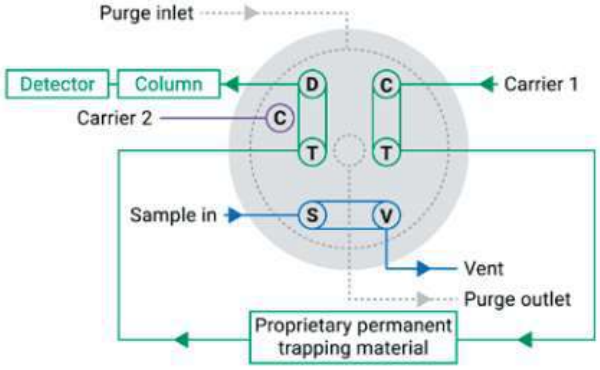
Step 2 – Vent



Step 3 – Isolate



Step 4 – Release



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Struggling to get **high dilution ratio** for trace gas generation?

Get unparalleled precision with our portable high-end **gas calibration system (GCS)** thanks to our sonic orifice technology.

Designed for ultra-trace calibration.

Accurately calibrate sulfurs at just a few ppb.

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Intelligent gas calibration/dilution system (GCS)

The data provided by your analytical system is only as accurate as your calibration.

Gas calibration and analytical system performance validation depends on knowing how to accurately dilute gas standards. Our high-end dilution system, based on a laser-calibrated orifice, is the result of over 30 years of experience in the field so you can count on unparalleled precision.

Features

- Sonic orifice technology with high dilution ratios from 1:2 to 1:3500 (custom up to 1:10000)
- High precision (<0.5% rel.)
- High sample integrity with purged electronics pressure regulator
- Advanced mathematical model to enhance precision and stability
- Heated flow path up to 200 °C
- User configurable orifice
- Optional inert flow path for sulfur and reactive gas analysis
- NIST traceable certificate available

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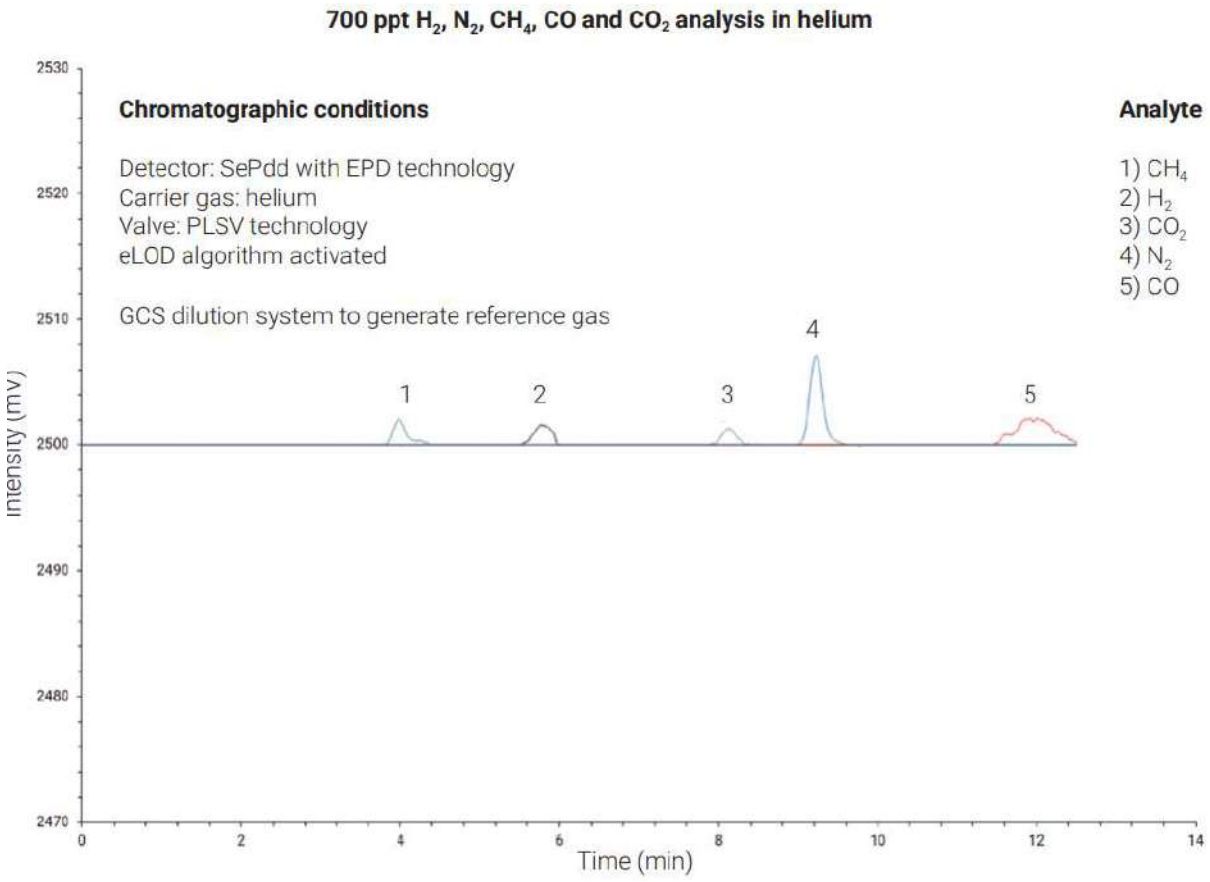
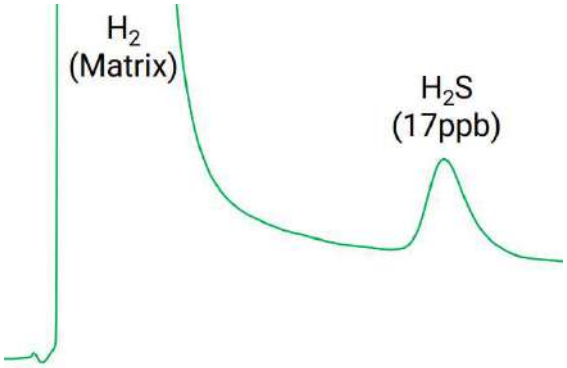
Generating trace reference concentrations for validation and calibration





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Contact us today!

Are you interested in ASDevices' products? Our team is at your disposal to answer your questions and evaluate your needs.

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ASDevices

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